



# Design Verification

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Design

Commissioning

Operation and Maintenance

- Aspects of Design Verification
  - Site conditions evaluation
  - Design evaluation
  - Equipment evaluation
  - Structural and electrical evaluation
  - Local code compliance



- Equipment Evaluations
  - Design Qualifications for Modules
    - IEC 61215 Crystalline Silicone, IEC 61646 Thin Film
    - IEC 61730/UL 1703 - PV module safety qualification
  - Inverters/optimizers/combiner boxes
    - IEC 62109/UL 1741 - Safety of power converters
    - IEC 62891 - Overall efficiency of grid connected photovoltaic inverters
  - Grid connectivity
    - IEEE 1547 - Interconnecting Distributed Resources with Electric Power Systems

- **Grid codes/performance standards**

- IEC 62446, Grid connected photovoltaic systems – Minimum requirements for system documentation, commissioning tests and inspection
- Germany: BDEW (TR3, TR4, TR8), VDE-AR-N 4105
- Italy: CEI 0-16, CEI 0-21
- Spain: P.O. 12.3, RD1663, UNE
- France: EDF, UTE C15-712-1
- UK: ER G59 Issue 2
- Belgium: C10/11
- Thailand: PEA
- South Africa: SAGC
- China: Golden Sun
- USA: FERC ORDER 661-A, WEEC, CAISO, NFPA 70, NERC PRC-024-1
- General: IEEE 1547, EN 50530, EN 61683, IEC 62116, IEC 61727

- Equipment Evaluations
  - IEC 62093 - Balance-of-system components for photovoltaic systems - Design qualification
    - Is written for dedicated solar components such as batteries, inverters, charge controllers, system diode packages, heat sinks, surge protectors, system junction boxes, maximum power point tracking devices and switch gear, but may be applicable to other BOS components.
  - Racking & Mounting
    - UL 2703, cover rack mounting systems, mounting grounding/bonding components, and clamping/retention devices
  - Cables/Harnesses/Connectors
    - IEC 60228:2004, Conductors of insulated cables
    - EN 50521, Connectors for photovoltaic systems
  - Trackers
    - UL 3703 - Solar Trackers intended for installation as freestanding units

- System Design
  - IEC 62548 PV Arrays – Design Requirements
    - This Technical Specification sets out design requirements for photovoltaic (PV) arrays including d.c. array wiring, electrical protection devices, switching and earthing provisions. The scope includes all parts of the PV array up to but not including energy storage devices, power conversion equipment or loads.
  - IEC 62738 Design guidelines and recommendations for photovoltaic power plants
- Installation – local codes



- Installation – local codes
  - National Electrical Code (NEC) NFPA 70
    - Article 690 – Solar Photovoltaic Systems
  - IEC 60364, Low-voltage electrical installations
    - rules for the design, erection, and verification of electrical installations (attempt to harmonize across countries)
  - Californian Fire Marshal
    - SOLAR PHOTOVOLTAIC INSTALLATION GUIDELINE
      - (In partnership with interested local fire officials, building officials, and industry representatives)
      - UL 1703 New Fire Testing requirements
  - Florida
    - Miami Dade Checklist # 0443 for the Approval of: Solar Collectors (Photovoltaic Devices)

- Site conditions evaluation
  - Environmental Conditions
    - Moisture
    - Corrosive environment
    - wind/snow loads
  - Underground
    - Rocks/ Shales underground
    - Seismic conditions
  - Additional Product Testing
    - Extensive Loading Testing, Wind tunnel
    - Salt Mist test
    - Ammonia exposure



- System component interconnect
  - Conditions of acceptability
    - Recognized components
    - Limited Certifications
    - Conditional acceptance
    - Restriction of use environment
- Mutual Data acceptance
  - Country codes vs international standards
  - CB labs, Notified Bodies, NRTLs



# Design Verification Questions ?

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